Nano-Firillar Ceramics by Gas-Phase Reduction

S. Akbar and K. Sandhage, The Ohio State University, DMR- 0309558

High surface area structures have been shown to enhance chemical sensitivity and catalytic activity. Recently, the PI's laboratory reported titania (TiO_2) nano-fibers by gas phase reaction in H_2 bearing atmosphere. During the gas phase reaction, each titania grain transformed into arrays of single crystal nano-fibers by an etching process, called "nanocarving". Lately, we found other nano-structures such as nano-whiskers and nano-channels by simple gas phase reaction (Fig. 1). Nano-whiskers formed during air-annealing of the nano-fibers reported earlier. For the nano-channel formation, titania samples were sintered at 1100 °C, which was 100 °C lower than the sintering temperature for the nano-fiber formation. The nano-channels were rectangular in shape and aligned in the (001) direction, same as the fiber direction.

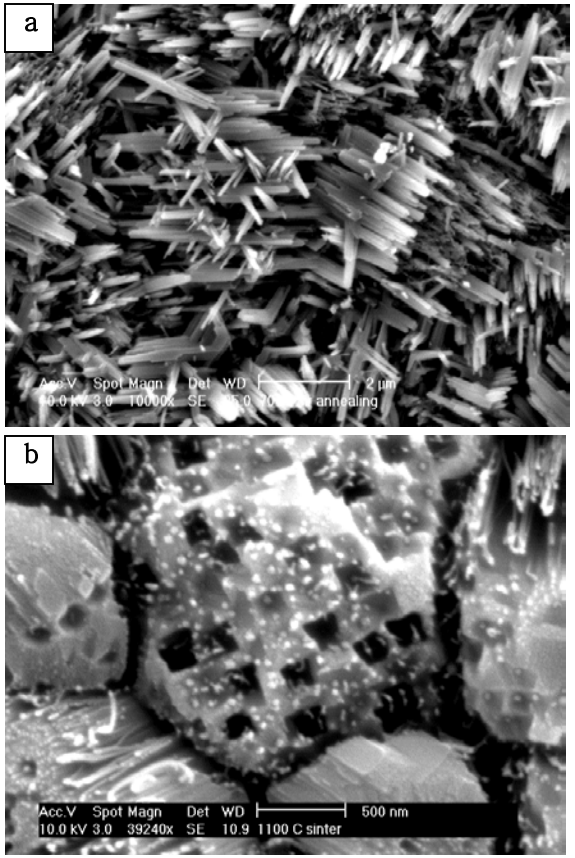


Fig. 1 (a) Nano-whiskers and (b) nano-channels by gas phase reaction in rutile TiO_2.

Educational and Broader Impact Activities:

• The results from this project are being readily integrated into the lecture materials of two newly developed courses at OSU (**MSE 673**: Sensor Materials – a Multidisciplinary Approach and the IGERT course, **MSE 694A**: Introduction to Molecular Engineering of Micro-devices), as well at GATech (**MSE 4803/8803**: Nano-materials and Nano-fabrication and **Eng 1001**: Introduction to Engineering). Students (undergraduate and graduate) are taking these courses and applying them toward core or technical electives as required by their degree program. The OSU courses have been integrated into the newly developed "Electronic Materials" track of the undergraduate degree program in the Department of Materials Science and Engineering.

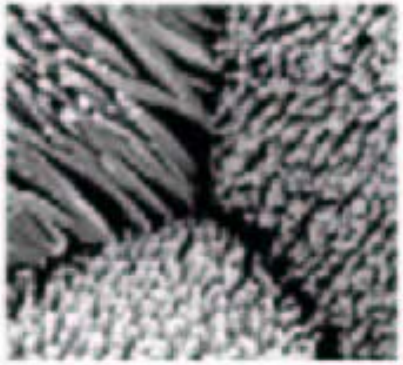
• Ms. Chia-Yun Chou at OSU is working on her undergraduate senior thesis project, where she is employing the nano-fibrillar structure as a platform for sensing reducing gases such as H_2 and CO.

• The results are also being disseminated by publications in peer-reviewed journals (Advanced Materials, 16[3], 260-264 (2004); Ceramics International, 30[7], 1121-26 (2004)) and presentations at national (Cocoa Beach meeting of ACerS) and international meetings (ICMAT in Singapore and IMCS in Japan).

• Given the potential impact of these nano-structures in wide-ranging applications (e.g., sensing, catalysis, photo-catalysis and bio-medical), our research is getting coverage in popular media such as The Hindu (India, Dec. 2003), BusinessWeek (Jan. 19, 2004), Ceramic Bulletin (March and August 2004) and other magazines.

Business Week
Jan. 19, 2004

http://www.businessweek.com/



-- Because ceramics are so brittle, machining them can be a nightmare. Ask most engineers to carve filaments 1,000 times as thin as a human hair, and they'll throw up their hands. But it's a snap for Sehoon Yoo, a materials-science student at Ohio State University. He bakes titanium-dioxide ceramic in hydrogen gas, and its surface develops deep holes that create ceramic hairs no more than 50 nanometers wide. How does it happen? Nobody knows. Yoo hopes to earn his PhD figuring it out.

In the media …

OSU Research News (December, 2003)
Eurekalert.org (December, 2003)
Innovations-report.com (December, 2003)
Nanoxchange.com (December, 2003)
Jef's web files (December, 2003)
The Hindu (India, December, 2003)
Environmental Security Scanning (December, 2003)
Betterhumans.com (January, 2004)
Sensors (January, 2004)
e4engineering.com (January, 2004)
Frost & Sullivan (January, 2004)
Newswise (January, 2004)
Business Week (January 19, 2004)
Ceramic Bulletin (March, 2004)
Ceramic Bulletin (August, 2004)